REMARKS

Claims 1-4, 6, 7 and 20 are pending in this application. Claims 1-4, 6, 7 and 20 are rejected. Claims 1 and 3 are herein amended. Attached hereto is a marked-up version of the changes made to the claims by the current amendment, captioned "Version with Markings to Show Changes Made."

Claim Rejections under 35 U.S.C. §103

Claims 1-4, 6, 7 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,001,452 to Imai et al. in view of the abstract of JP 01-103994 to Imai et al., along with U.S. Patent No. 5,977,697 to Jin et al.

Applicants respectfully disagree with the above rejection, because not all of the claimed limitations are taught by the cited reference.

The present invention is an n-type semiconductor. Applicants herein amend the independent claims to confirm that the n-type semiconductor diamond exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as p-n junction device.

Applicants note that when forming a p-n junction device, it is required not only being capable to obtain n-type conductivity and p-type conductivity of the semiconductor, but also crystal completeness that is sufficient to operate as p-n junction device.

For example, when lattice defects, such as interstitial impurities, dislocation, vacancy or lattice distortion exist, leak current occurs in a p-n junction device, and it becomes difficult to function as a p-n junction device.

Unlike the cited reference, the n-type diamond of this invention has enough characteristics for forming a p-n junction device. That is, the sulfur atom forms single donor level 0.38 eV (noted in Fig. 6 of the specification), which means that the carbon atom of the diamond lattice is substituted completely by the sulfur atom and the sulfur atom makes no lattice defects.

Moreover, the carrier mobility exhibits 3/2nd power temperature dependency, which is the necessary feature of a semiconductor for p-n junction device (refer to Figs. 7-9 in the application). Further, it has very narrow Raman spectrum half-width (refer to Fig. 10), exciton luminescence (refer to Fig. 11), and the electron-diffraction pattern shows the Kikuchi pattern (refer to Fig. 12).

These properties all show that the interstitial impurities, dislocations, vacancy and crystal distortion do not exist in the n-type diamond of this invention. That is, the n-type diamond of this invention is n-type diamond with a necessary property to a p-n junction device.

The example of an actual proof from which a good p-n diode property is obtained with the n-type diamond of this invention is shown in Reference Figure 2, which is also cited in Japanese application JPA 11-174722. The p-n diode used for this measurement was formed by using a well-known B dope p-type diamond substrate, by polishing the substrate surface following the method of this invention, that is, the plane normal of this substrate incline in the range of 1.5-6 degrees to the <100> direction in the plane that the <100> direction and the <001> direction make, or the plane that the <100> direction and the <010> direction make. By exposing this surface to hydrogen plasma, the stair-shaped surface as shown in (b) of Fig. 1 was obtained. By exposing this surface to the microwave plasma of the gas which consists of volatile hydrocarbon, a sulfur compound, and hydrogen, epitaxial growth of the sulfur dope n-type semiconductor diamond was formed.

From Figure 2, it is seen that this p-n junction device has a good rectification property in the temperature range from a room temperature to 500°C, and particularly leak current can not be seen at all in the reverse bias voltage region. On the other hand, it is only shown that the diamond in Imai '452 exhibits n-type conductivity and the value of the carrier mobility is high.

Moreover, in column 3, lines 53-61 of Imai '452, the text reads as follows:

> "Without being bounded by theory, these electrons serving as donors are believed to contribute to the n-type semiconducting properties of the diamond. In other words, S or Se introduced in the diamond as a dopant creates a donor level in the inhibition band. In certain cases, S or Se might cause a Frenkel defect (i.e., the simultaneous presence of one vacancy and one interstitial impurity atom) rather than substitution in regular carbon lattice sites, and this may also serve to create donor levels."

Specifically, Applicants note that, "the diamond which has n-type conductivity" appears to be indicated by the cited reference Imai '452, but n-type diamond that "exhibits crystal completeness sufficient to allow operation of said n-type semiconductor diamond as p-n junction device" is **not** indicated. That is, if donor is based on impurities between lattice sites and vacancy, even if n-type conductivity is obtainable, but it is difficult to operate as a p-n junction device because of the leak current at the p-n junction based on such lattice defects.

Therefore, Applicants submit that claims 1 and 3 patentably distinguish over the cited references. And because claims 2, 4, 6, 7 and 20 are dependent claims and naturally include at least the limitations in independent claims 1 and 3, Applicants assert that these claims are in condition for allowance as well.

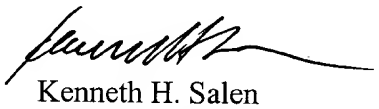
For at least the above reasons, Applicants submit that the claimed invention, as herein amended, defines patentable subject matter. Applicants request withdrawal of the rejections and passage of the claims to issue.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, WESTERMAN & HATTORI, LLP



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